

Wind Energy Research, Assessment and Development



*Uwind*  
*A University of Utah Start-up Company*

[www.utahwindpower.com](http://www.utahwindpower.com)

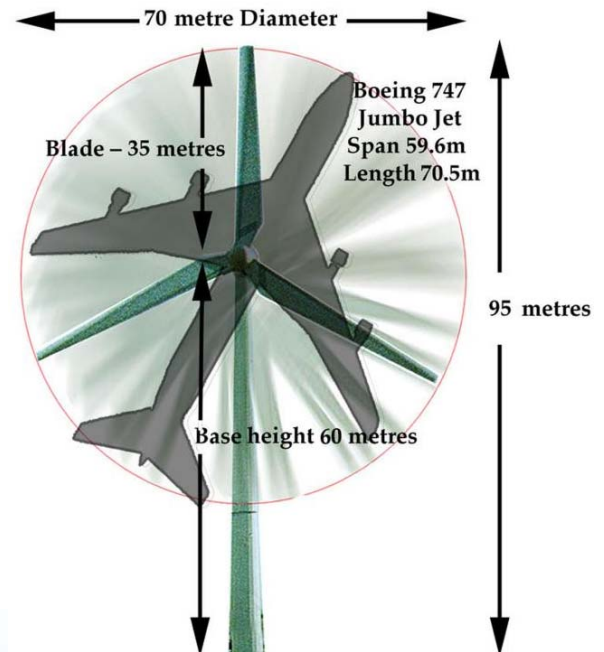
Tim Dwyer, Co-Owner

UWWG Presentation

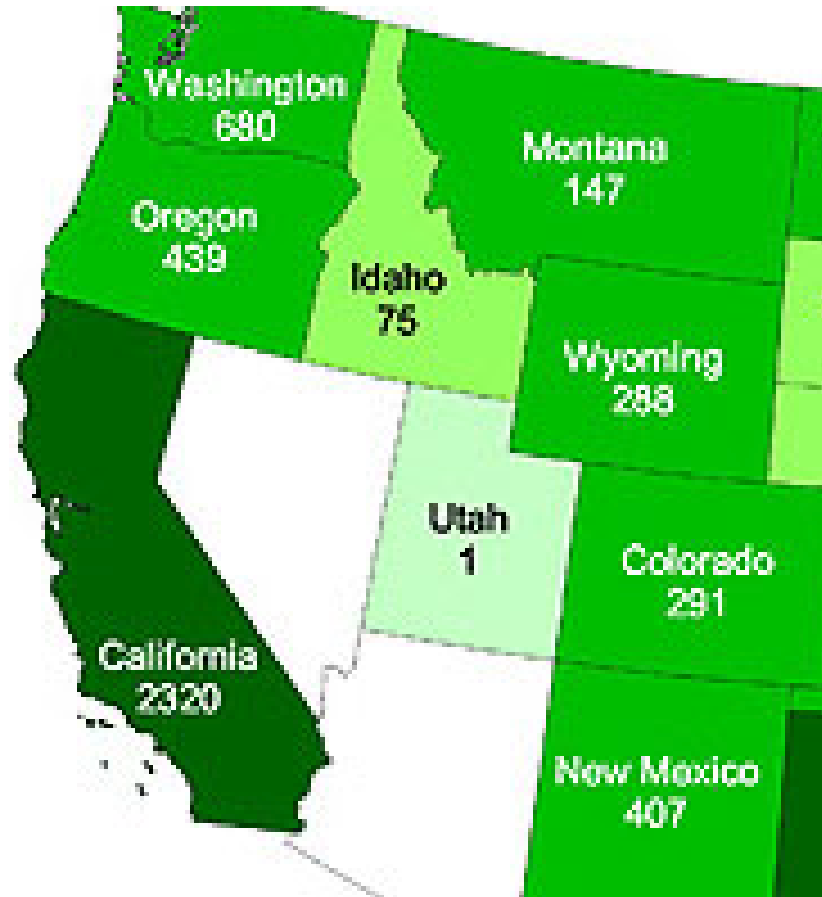
August 13, 2007

# U.S Wind Energy Market

- Large Wind
  - The U.S. wind energy industry is on track to add well over 3,000 megawatts (MW) to the nation's power generating capacity in 2007, topping last year's record of 2,454 MW, (AWEA)
- Small Wind
  - AWEA: generate 3% of nations electricity from small wind by year 2020
  - A Total of 50,000 MW
  - Industry growth to \$ 1 Billion / year



# Why Wind in Utah?



# Uwind LLC

- Formed in October 2006 by Tim Dwyer and Morgan Farley-Chrust.
- Company Based on Engineering and Atmospheric science expertise at the University of Utah.
- Mission: to provide wind measurement and data analysis services to a developing wind energy market.



# Currently: **Uwind's Services**

Providing State-of-the-Art SODAR  
Micrositing and Atmospheric Data  
Analysis Services:

## In the Future:

Providing Complete Utility Scale  
Consulting Wind Resource Analysis  
Services:

Met Tower Installations

Continued SODAR Micrositing

Wind Resource Site Mapping and  
Modeling

Optimization of proposed wind farms



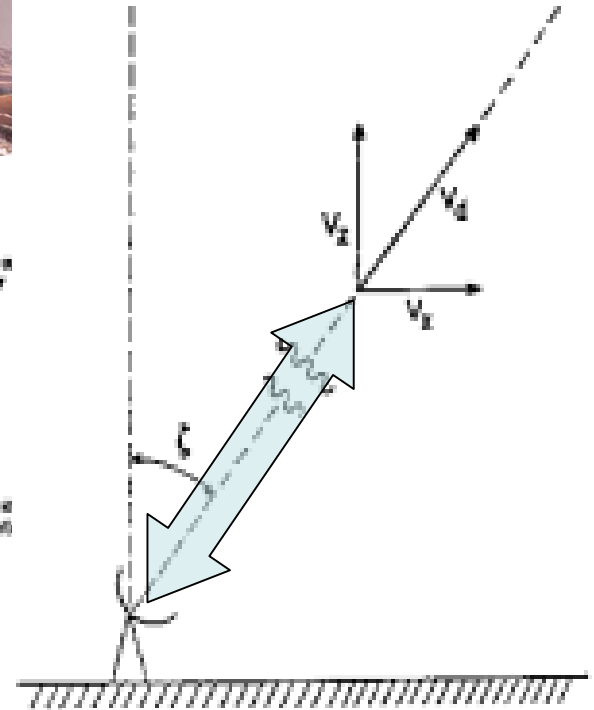
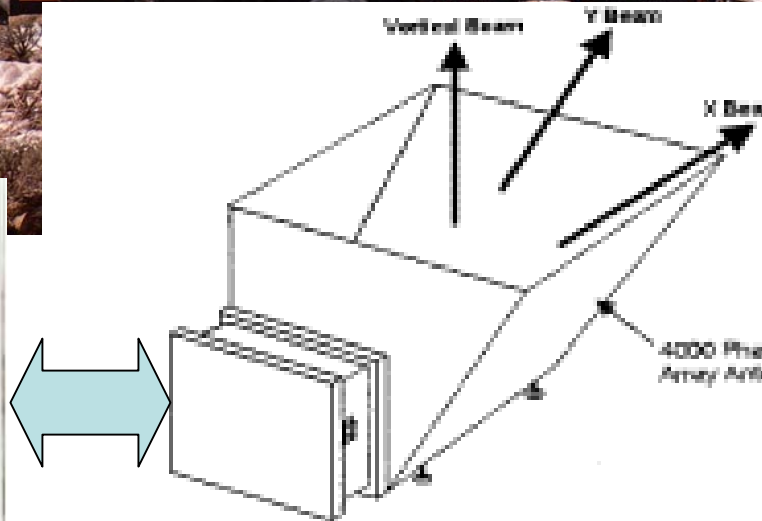
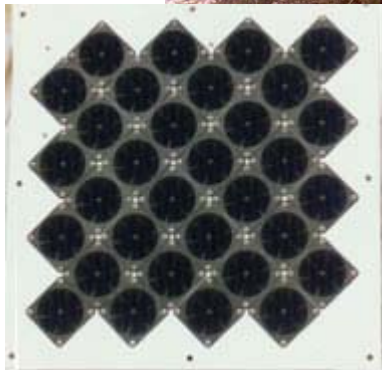
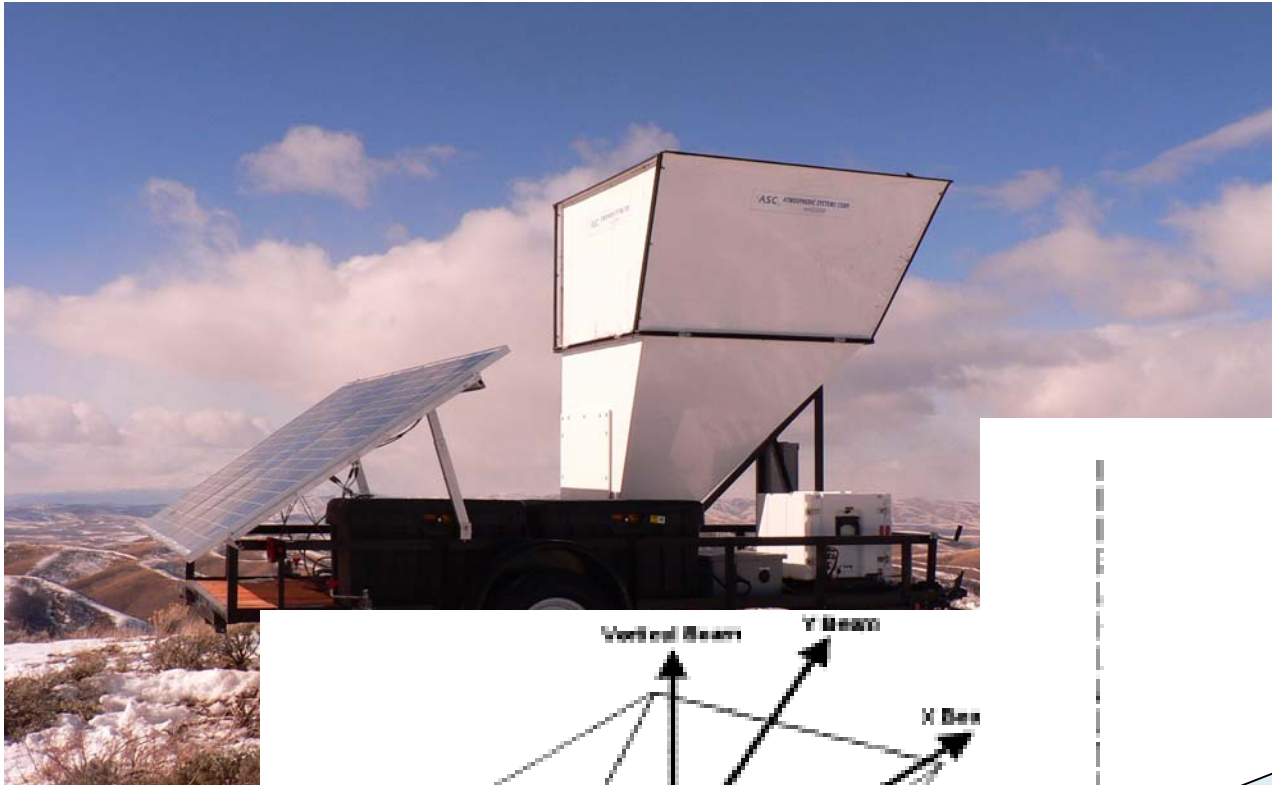
# SODAR

- What is SODAR?  
(SOnic Detection And Ranging)
- Portable, Ground based measurement system designed to measure atmospheric turbulence and the wind profile from 15 meters up to 250 meters.





# How SODAR Works



# Benefits of SODAR

## PROS:

- Continuous profile data
- At each height 5 – 200m:
  - 3 components of velocity
  - Standard deviations and Turbulence Intensity
  - S/N Ratio for data reliability checks
- Mobile
- More Complete data sets for potential sites
- Industry accepted.

## CONS:

- Expensive
- Requires more on-site attention than traditional Met towers
- Audible beep, limits deployment in residential areas.
- Inaccurate data heavy precipitation





# **Siting Wind Farms in Complex Terrain: Spanish Fork Canyon a Case Study**

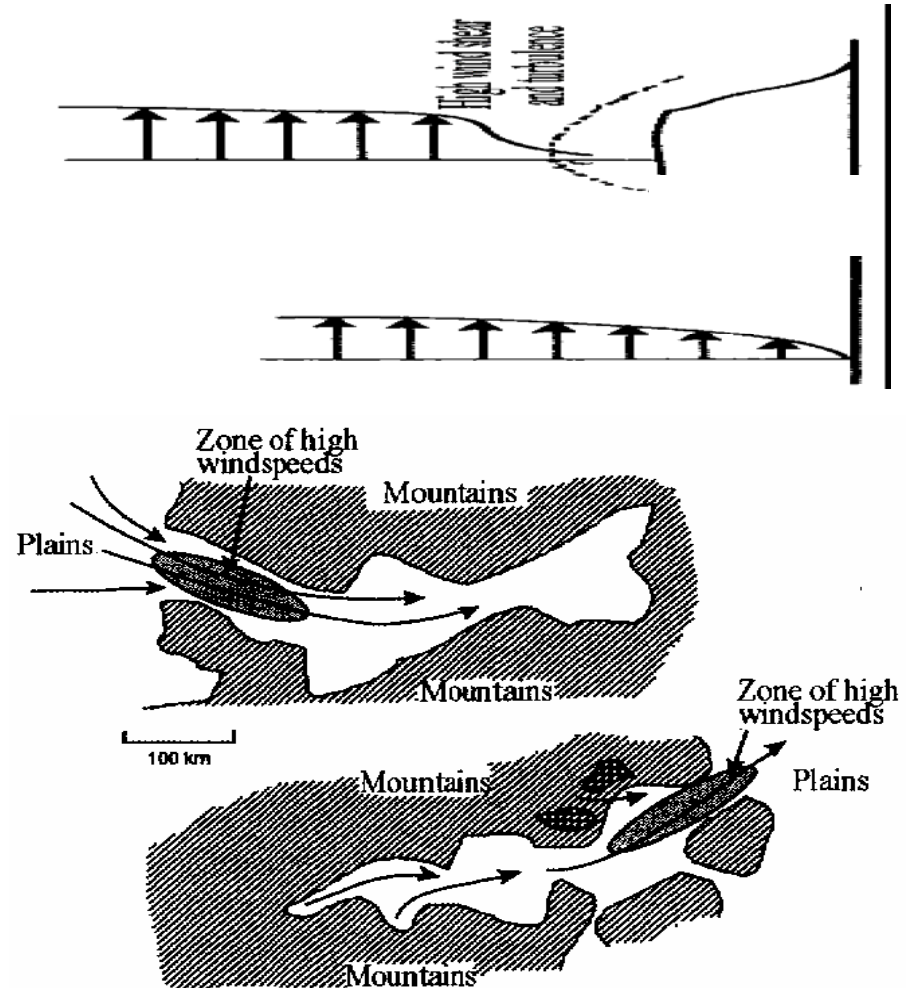
May 23, 2007 Havana, Cuba

Dwyer, Tim BS; Farley-Chrust, Morgan BS; McMurtry,  
Patrick Ph.D; Pardyjak, Eric Ph.D

University of Utah,  
Salt Lake City, Utah USA.

# Why Complex Terrain?

- Rapidly Growing World Wide Wind Energy Market.
- Terrain Features Enhance Wind Fields
- Non-Trivial Nature of Wind in Complex Terrain Needs to Be Understood.

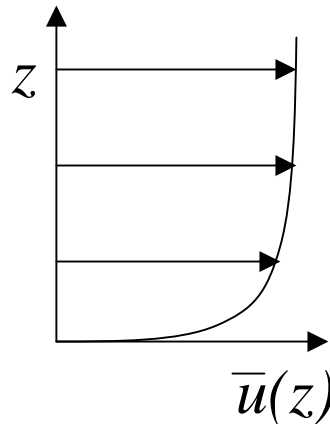


Figures from Wegley et. Al.  
(1980) and Rohatgi (1994)

# Wind Speed Profile

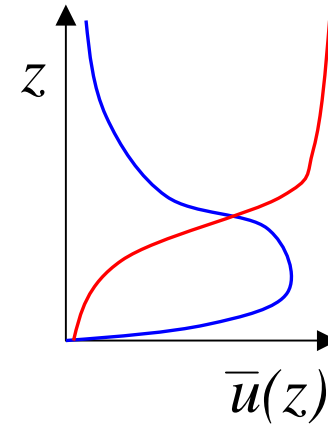
## Characteristics in Complex Terrain

- Diurnal Flow (daily direction and strength patternation)
- “Non-Classical” velocity profiles



Mean Wind Characterized by

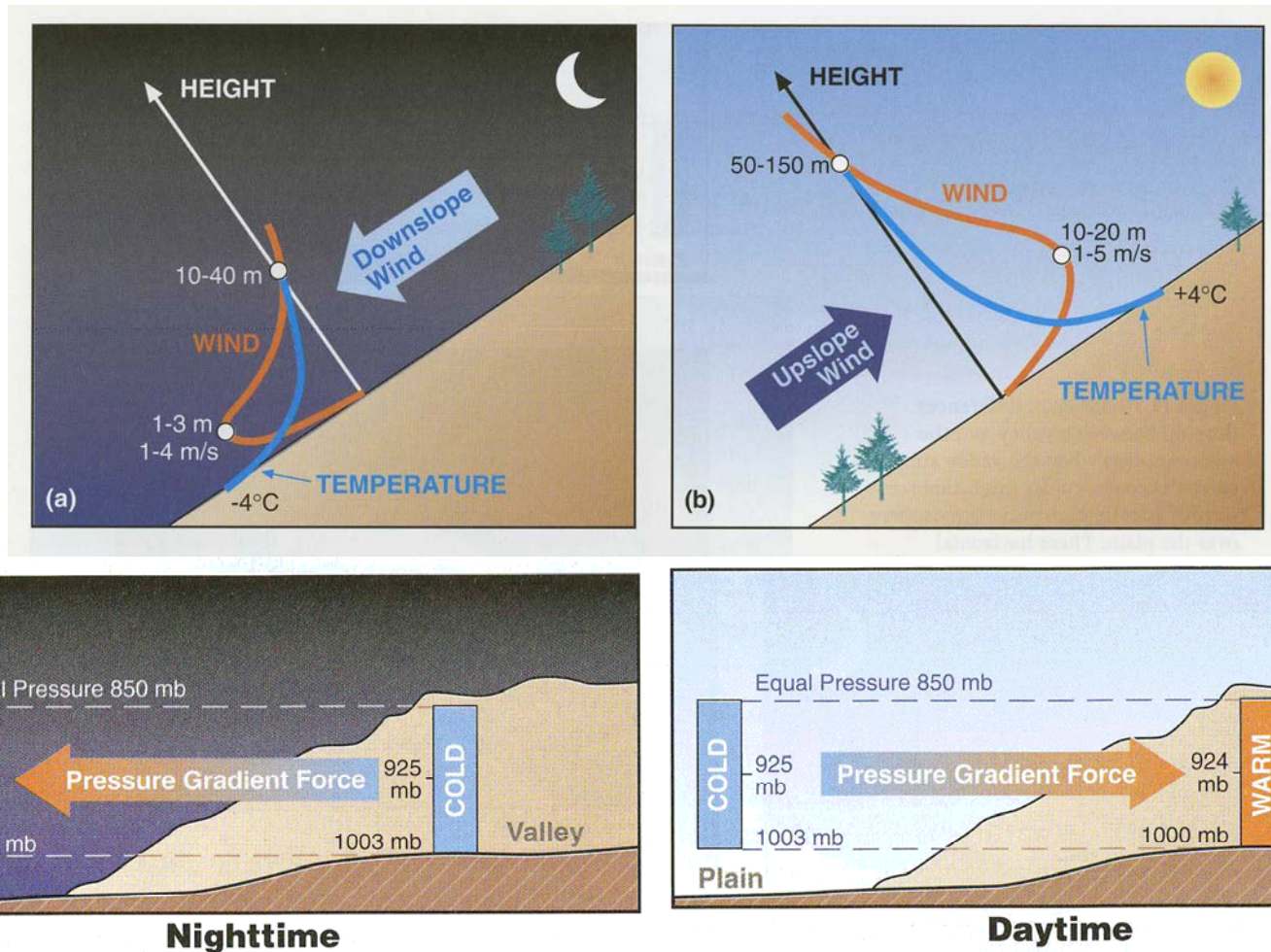
$$\frac{\bar{u}(z)}{u_{ref}} = \left( \frac{z}{z_{ref}} \right)^p \quad \text{or} \quad \frac{\bar{u}(z)}{u_*} = \frac{1}{k} \ln \frac{z}{z_o}$$



Not Easily Characterized

$$u(z) = f(?)$$

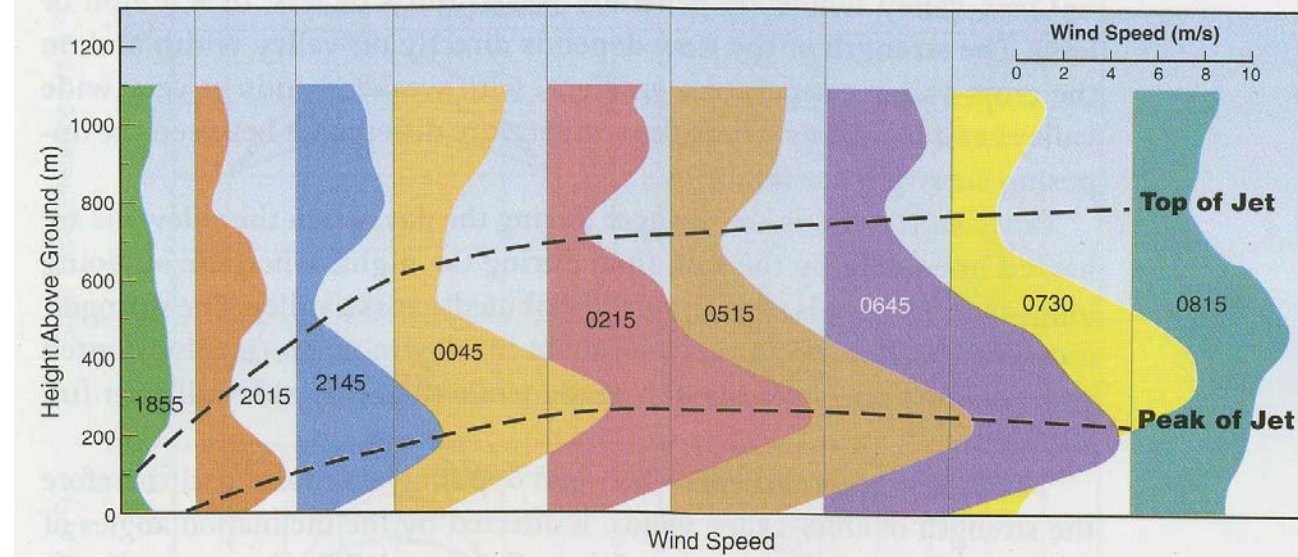
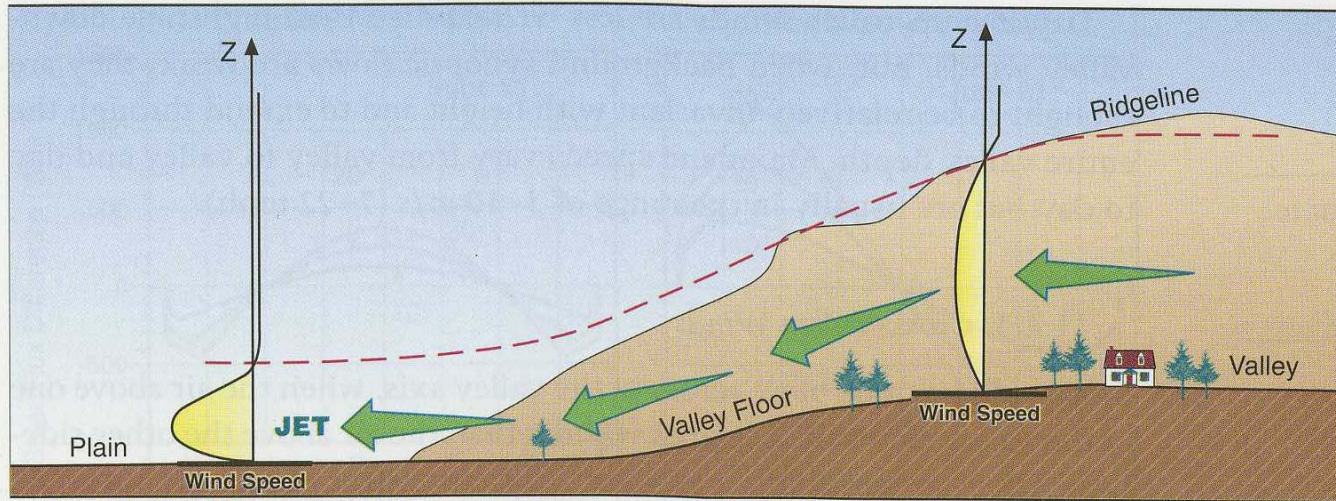
# Slope, Canyon and Drainage Flows



Figures from Whiteman (2000)

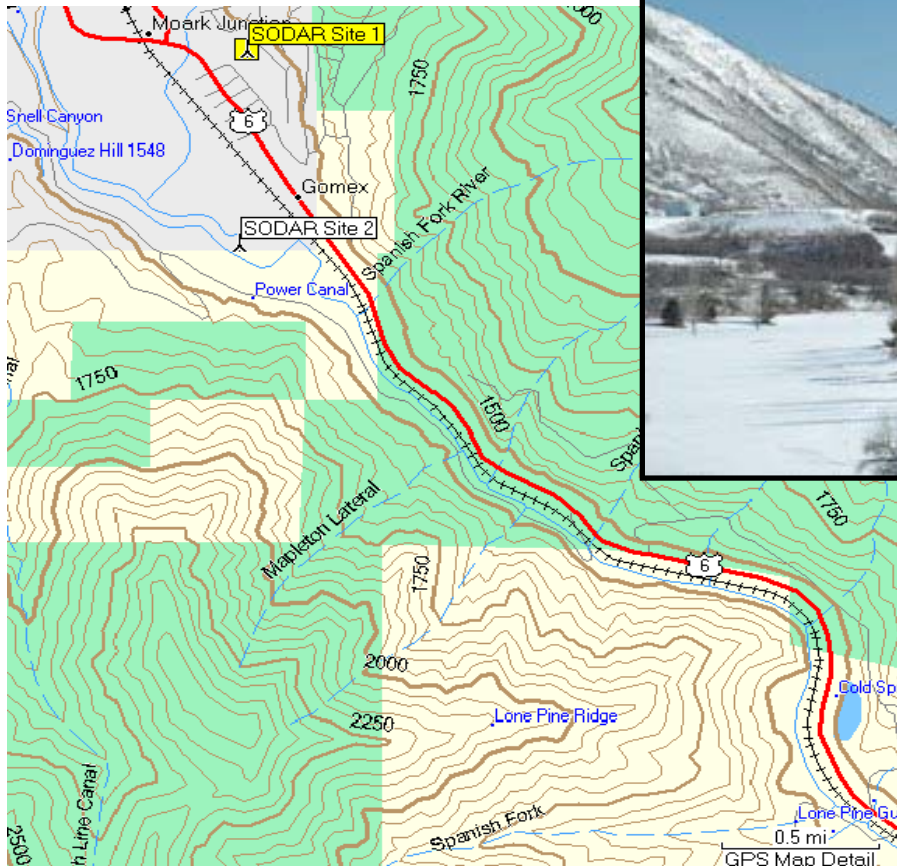


# Nocturnal Jet



Nocturnal profiles from Inn Valley, Austria. Figures from Whiteman (2000)

# Case Study: Spanish Fork Canyon

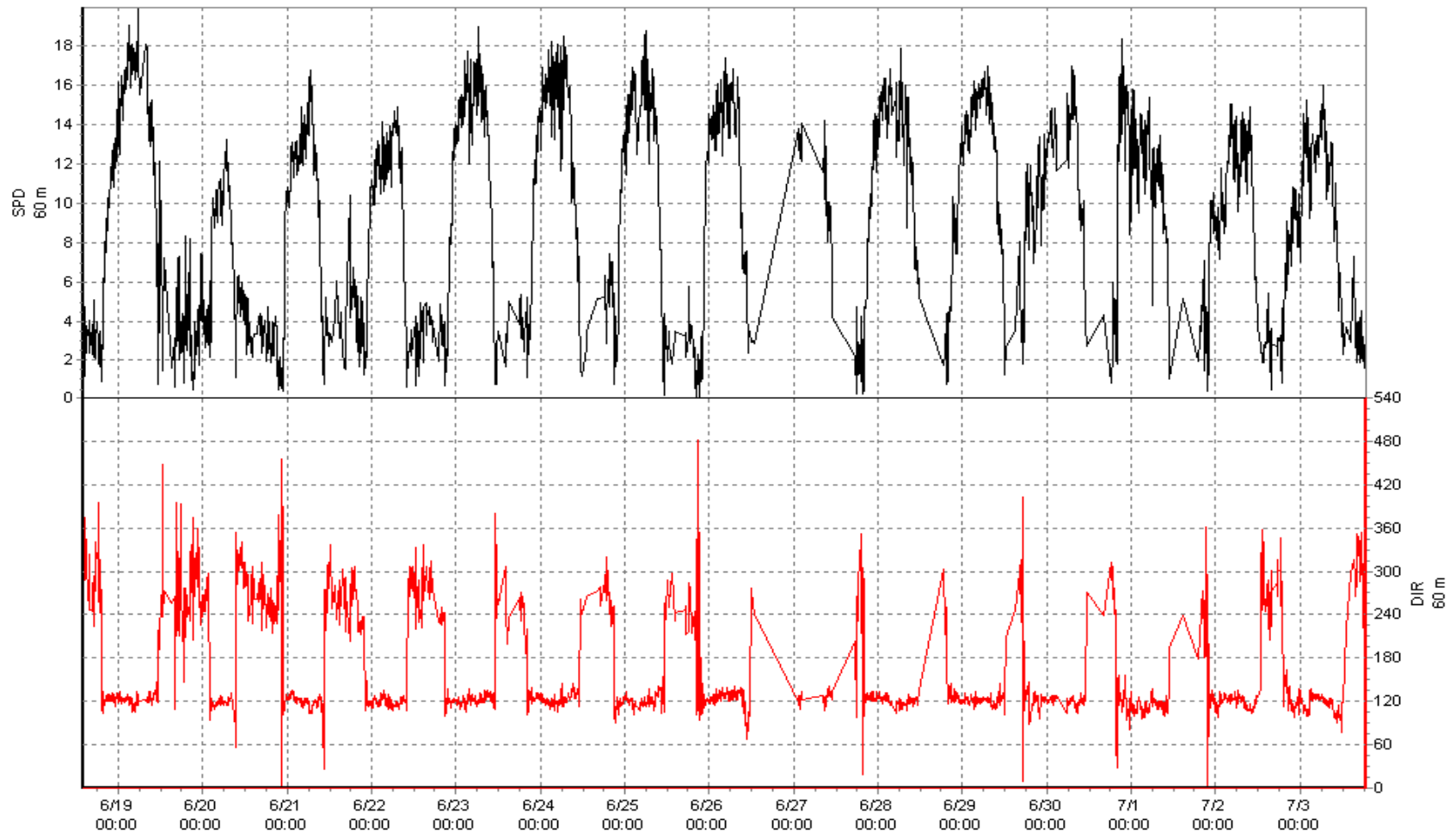


Topographic Map of Spanish Fork canyon, UT



Proposed Spanish Fork Canyon Wind Park

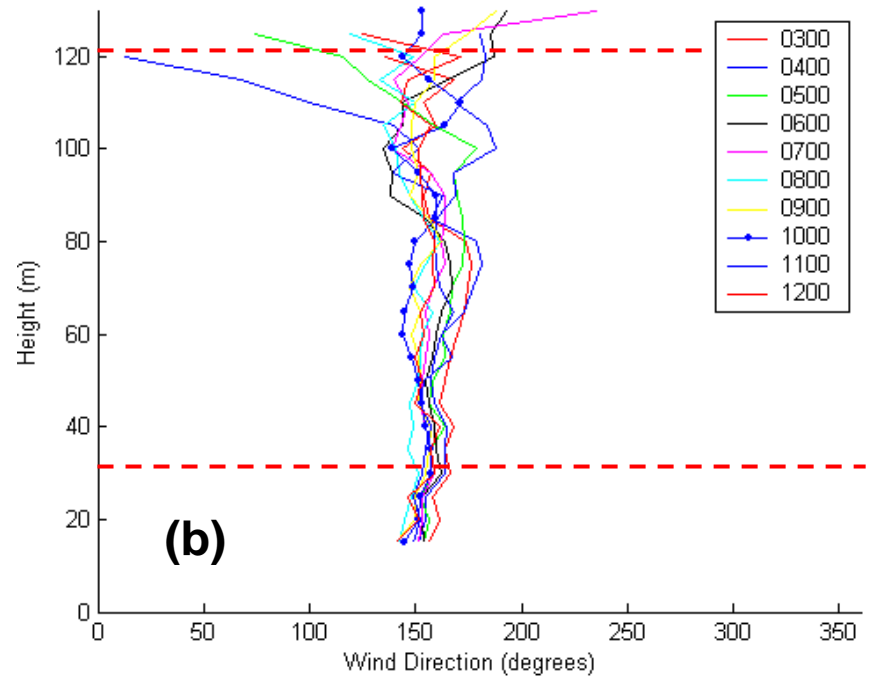
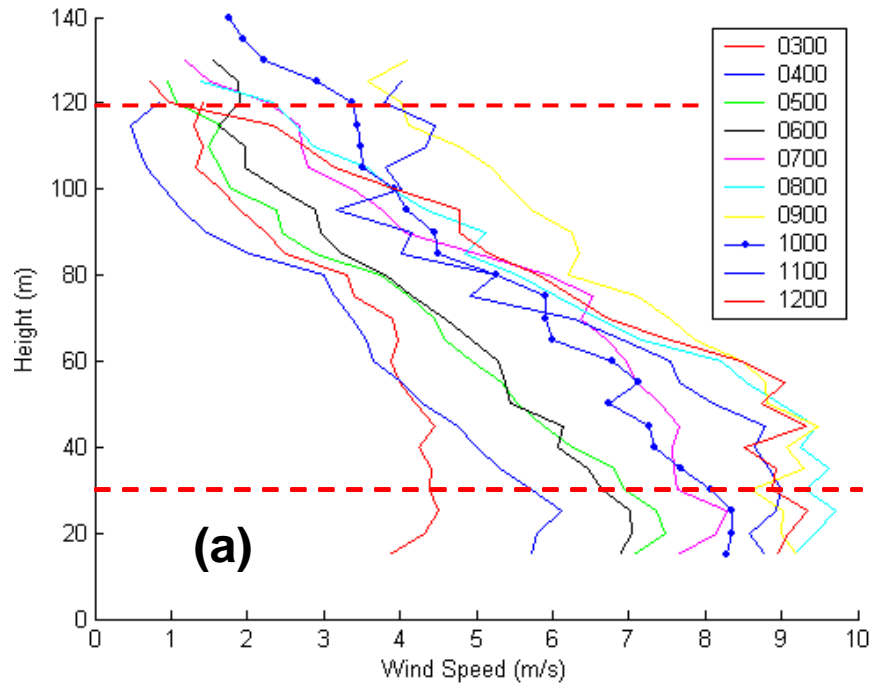
# Diurnal Flow Pattern



Diurnal wind speed (m/s) and direction (degrees) time series at 60m above ground during June 18, 2006-July 3, 2006  
10 Minute Average SODAR Data



# Nocturnal Jet

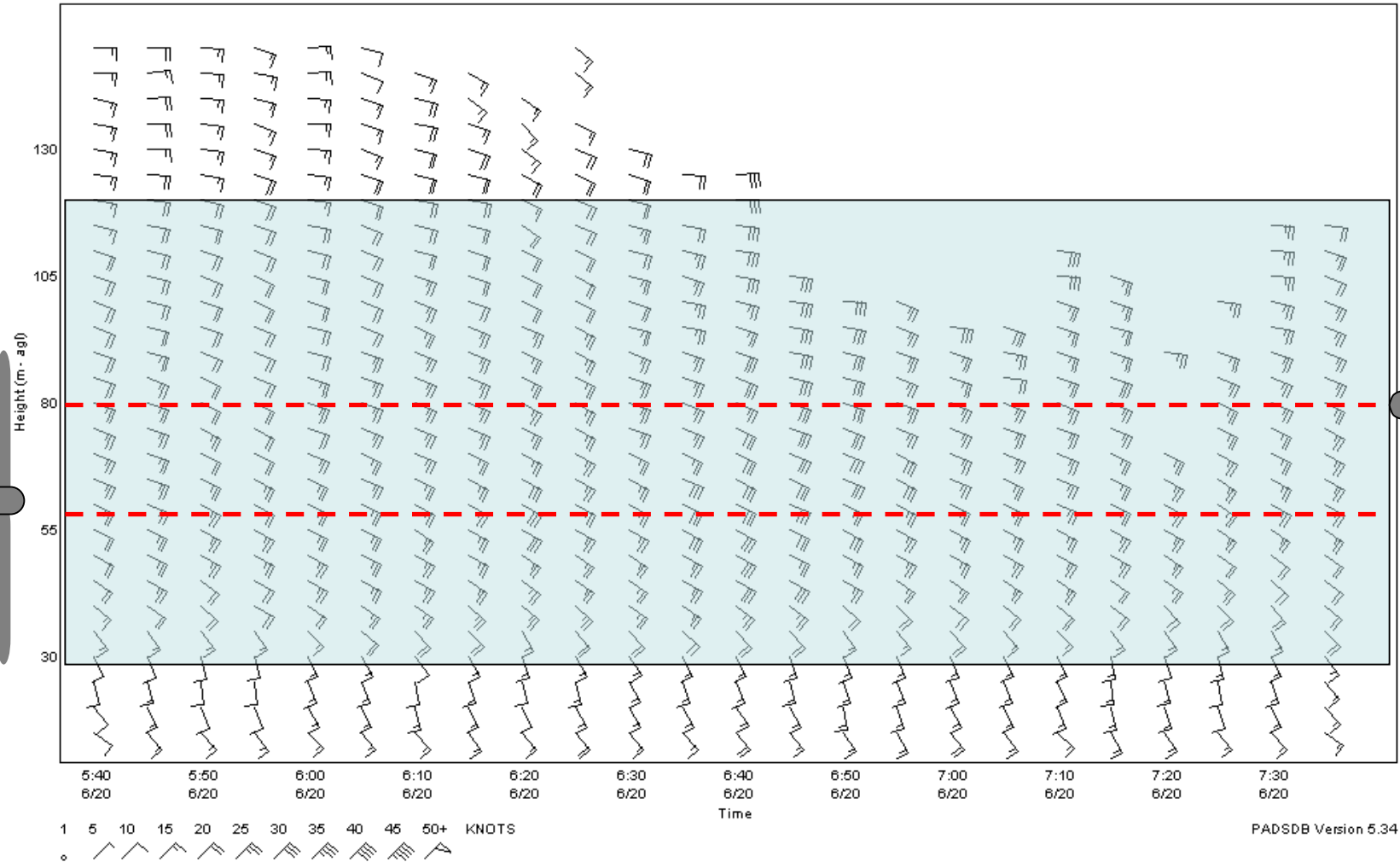


(a) Wind speed profiles showing low level jet development from Dec. 16, 2005  
(b) Wind direction profile for the same time period (0300-1200).

# Wind Shear

Station : Test

Date : 6/18/2006 - 7/3/2006



Wind Speed and Direction as a Function of Height and Time of Day

# Uwind in Transition

- Uwind is currently in transition to become a partner of a established wind resource assessment firm.
- This partnership will provide our company with full resource assessment capabilities including:
  - Meteorological Tower Installation
  - Numerical Modeling and Wind Farm Optimization
  - Wind Data management and comprehensive project feasibility consultation.

# **The Future: Uwind**

- Remain Based in Salt Lake City
- Providing Complete Localized Wind Resource Assessment Services for the Western U.S. and beyond.
- We are excited to help Wind power grow!

# Resources

- American Wind Energy Association
  - [www.AWEA.org](http://www.AWEA.org)
- Wind Powering America
  - [www.eere.energy.gov/windandhydro/windpoweringamerica](http://www.eere.energy.gov/windandhydro/windpoweringamerica)
- Atmospheric Systems Corporation
  - [www.minisodar.com](http://www.minisodar.com)
- REMTECH
  - <http://www.remtechinc.com/sodar.htm>
- Second Wind
  - <http://www.secondwind.com>

# References

- Whiteman CD, (2000) Mountain Meteorology: Fundamentals and Applications, Oxford University Press, ISBN 0-19-513271-8: 171-202
- Rohatgi JS, Nelson V, (1994) An analysis for the generation of Wind power, Alternative Energy Institute Canyon, Texas USA.
- Wegley HL, Ramsdell JV, Orgill MM, Drake RL (1980) A Siting handbook for small wind energy conversion systems, Battelle Pacific Northwest Lab PNL-2521,Rev. 1, NTIS.
- U.S. Department of Energy (DOE)
- National Renewable Energy Laboratory

# Questions?

